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Semiannual Report 3 | *Covering the Period 1 March through 31 August 1964*

RESEARCH-ENGINEERING AND SUPPORT FOR TROPICAL COMMUNICATIONS

Prepared for:

U.S. ARMY ELECTRONICS LABORATORIES
FORT MONMOUTH, NEW JERSEY

CONTRACT DA-36-039-AMC-00040(E)
ORDER NO. 5384-PM-63-91

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October 1964

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Approved: D. R. SCHEUCH, EXECUTIVE DIRECTOR
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I INTRODUCTION

A. HISTORICAL BACKGROUND

During World War II, United States military forces operated extensively in tropical areas, thereby gaining considerable practical experience in communication problems in tropical forest and jungle areas. The pressure of military objectives limited scientific explorations into many of the specific problems that arose, resulting in sizable gaps in our knowledge of communication in equatorial regions.

The friendly and cooperative working arrangement existing between Thailand and the United States resulted in the joint study of tropical communication problems by staff members of the Thailand Ministry of Defense and agencies of the United States. The Military Research and Development Center (MRDC), was organized as a joint Thailand-United States agency to conduct operational tests of military hardware and to foster research on many subjects in a tropical environment. Communications research is a major subject of interest in the MRDC.

The United States Army Electronics Laboratories (USAEL) and Stanford Research Institute undertook the task of establishing an Electronics Laboratory in Thailand to facilitate a first-hand study of tropical communication problems. Staffing of the laboratory is a joint United States-Thailand venture, with United States participation largely from members of the staff of Stanford Research Institute.

Over-all direction of the United States portion of the MRDC has been assigned to the Advanced Research Projects Agency (ARPA) of the Department of Defense. ARPA actively monitors and directs the work of the USAEL and Stanford Research Institute.

B. OBJECTIVES

The purpose of the project under Contract DA-36-039-AMC-00040(E) is to support the MRDC in the areas of tactical and tropical communication. The specific objectives of this effort are to:

(1) Survey, analyze, and evaluate the capacity, reliability, and physical and tactical limitations of existing communication facilities, equipments, and techniques.

(2) Generate from the above survey, analysis, and evaluation a set of requirements for field communications based upon tactical considerations and specific equipment characteristics that will satisfy these requirements.

(3) Test off-the-shelf equipments that come as close as possible to satisfying each set of the above requirements, these tests to be first technical and then tactical for items that show promise.

(4) Analyze and evaluate the tests and recommend areas for future emphasis.

(5) State equipment requirements to accomplish the task of jungle field communication, based upon existing and anticipated tactical requirements.

(6) Train the Thai personnel assigned to the Electronics Laboratory so that they are able to utilize the facility, accomplishing this training as a natural course of operating the laboratory.

(7) Aid electronic projects in Thailand as practical, encouraging projects that appear especially useful to the basic objectives of the MRDC.

(8) Field test selected items of communication equipment in Thailand in accordance with the requirements of the President's Counter Insurgency Committee.

I. TASK I--OPERATIONS ANALYSIS PROGRAM

A. PROGRAM OBJECTIVES

The objectives of the Operations Analysis Program are as follows:

> To conduct studies in which the requirements for research and development of military communications equipment and systems will be determined. Particular consideration will be given to effects upon tactical communications imposed by the unique geophysical environment, human factors, and likely levels of military conflict which may occur in Southeast Asia. Primary emphasis will be on enhancing the counter-insurgency capabilities of Thailand. This research effort should lead to the identification of the essential operational characteristics and capabilities of the required communications equipment and systems and to guidance for the achievement of such capabilities through appropriate research, development, test, and evaluation.

B. STUDIES AND REPORTS PROGRAM

The Operations Analysis Program is described in an SRI memorandum, "Studies and Reports Program," dated 26 August 1964. This memorandum was submitted to the Communication Program Manager, ARPA-RDFU, Bangkok, Thailand to set forth the studies and written reports to be prepared. It also suggests priorities, and gives personnel assignments and target dates for each study. The program was submitted on 26 August 1964 to the COR/COTR, USAEL, Bangkok, the MRDC Electronics Laboratory Coordinator, and the ARPA Communications Program Manager, for comment and/or concurrence. The program memorandum was developed as the result of numerous conferences regarding the Operations Analysis Program in the period 1 March to 26 August 1964. It is consistent with the SRI program transmitted by ARPA-RDFU, Bangkok, to the Thai Supreme Command, and approved by the Supreme Command on 31 July 1964.

The Operations Analysis Program is composed of six subtasks. Each subtask has one or more studies related to it. These subtasks and their associated studies are described below.

1. <u>Subtask 1--Communications for Low-Intensity Counterinsurgency (CI) Operations</u>

   a. <u>Study No. I--Border Patrol Police (BPP) Communications</u>

   This study covers the communications networks from HQ BPP, Bangkok, down through areas to platoons; communications from platoon HQ to individual patrols; interface communications with adjacent provincial police and military agencies; and an evaluation of the communications system to support the CI functions of the BPP in low-intensity CI operations.

   b. <u>Study No. II--Armed Forces Communications Systems</u>

   This study covers the fixed and semi-fixed communications networks from each of the senior headquarters down to Special Operations Centers (SOCs) and/or deployed comparable elements of each of the Services (Supreme Headquarters, RTA, RTN, RTAF, RTMC) that have a CI role, and an evaluation of the communication systems to support such roles in low-intensity CI operations.

2. <u>Subtasks 2 and 3--Communications for Medium- and High-Intensity Counterinsurgency (CI) Operations</u>

   a. <u>Study No. III--Communications Requirements for Small Units in CI Combat in Tropic Areas</u>

   This study includes a description of the environment and an assessment of its effects on radio communications in Thailand; the tactical requirements for communications of small units (battalion or smaller) and patrols in typical CI combat operations in the Thai setting; and an evaluation of the most significant factors and considerations in the design and operation of appropriate tactical communication equipment and systems.

b. <u>Study No. IV--A Study of the Applicability of Various Communication Transmission Techniques in Support of Small Unit Combat Operations in Tropic Areas</u>

This study covers a review and evaluation of the applicability of various current and exotic communications techniques--taking into account environmental, tactical, technical, economic, and human factors--in tropical, small-unit CI operations.

3. <u>Subtask 4--Communications Systems Implications of Major Thai Dialects</u>

a. <u>Study No. V--Thai Intelligibility Tests</u>

This study defines the rationale and development of the test, experimental results, and the effects of signal degradation on the intelligibility of Thai speech transmissions.

b. <u>Study VI--Evaluation of Thai Voice Transmissions in Tactical Communication Systems</u>

This study covers tests of, and will indicate, the intelligibility ratings of various manpack tactical radio systems for the transmission of Thai speech.

4. <u>Subtask 5 (Study No. VII)--Survey of Existing Communications Systems</u>

This study consists of two parts:

(1) The development of (a) individual station data forms, (b) catalog format, (c) central data filing and reference system, and (d) procedures for the organization, management, and operations of a central agency for the registration and up-to-date maintenance of information on existing communications installation in Thailand (military, civil, and private).

(2) An actual full-scale data-collection survey and the production of an initial catalog of existing communications systems in Thailand, involving the active participation of numerous Thai personnel under SRI guidance.

5. Subtask 6 (Study No. VIII)--Human Engineering and Thai Aptitudes

This study covers the investigation of communication personnel skills and abilities in order to determine what is required for: (1) equipment design and operational procedures, and (2) personnel selection, training, and placement to provide improved communication system performance.

C. PROGRESS AND CONCLUSIONS

1. Study Program Progress, 1 March to 31 August 1964

Figure 1 summarizes progress on the Task I study program by means of a bar graph that portrays for each study the accomplishments in terms of the steps leading to conclusions. Although the program has not reached the point where conclusions can be rendered based on the individual study reports, some preliminary conclusions can be rendered on three of the eight studies (Studies I, V, and VII). Four of the studies (Studies III, IV, VI, and VIII) are in the initial stages of data collection. One (Study II) is at the stage of processed data translation into a set of preliminary conclusions.

2. Preliminary Conclusions

The preliminary conclusions derived from the studies thus far are as follows.

a. Study No. I--Border Patrol Police (BPP) Communications

The BPP missions in the seven areas vary sufficiently to require the use of different organizations, procedures, and equipment in each area.

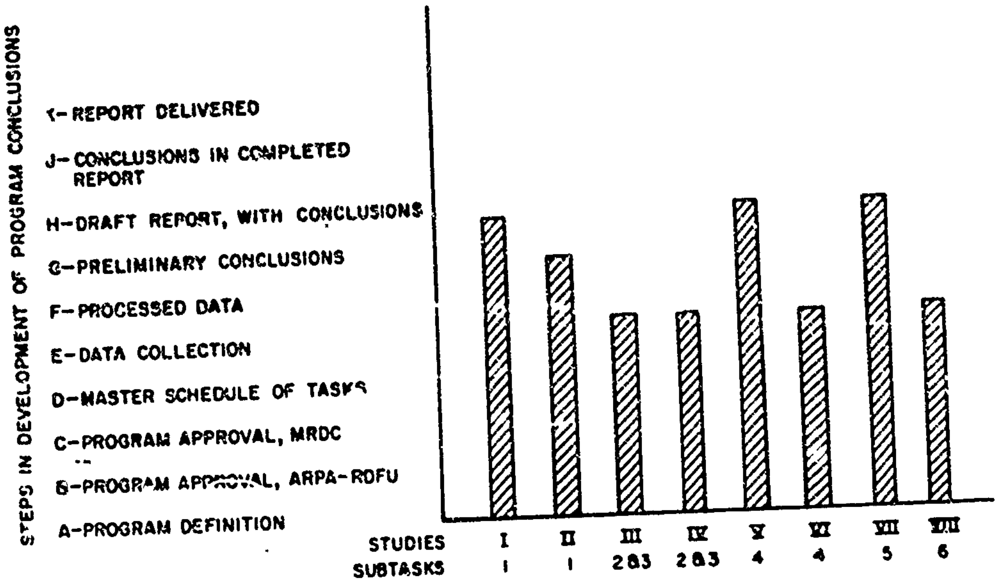

FIG. 1 TASK I STUDY PROGRAM PROGRESS CHART

b. Study No. V--Thai Intelligibility Tests

It has been found that many of the words contained in lists available in the U.S. are of relatively low frequency of occurrence in spoken Thai or restricted to literary or elegant expressions, and consequently are not suitable for use in an intelligibility test.

c. Study No. VII--Survey of Existing Communications Systems

The many incompatibilities among the governmental communications systems in Thailand lead to the preliminary conclusion that these resources would probably not be effectively utilized to their full capability in the event of a national emergency or increased insurgency operations. It is suggested that a single, long-haul communications system and a central communications management authority may be the possible solution to this problem. At the very least, a modern and efficient radio frequency regulating authority, together with a monitoring system, appears to be a necessity if the predominant radio communications systems are to play an effective role in the national defense of Thailand.

D. WORK ACCOMPLISHED DURING THE REPORTING PERIOD

1. <u>Subtask 1--Communications for Low-Intensity Counterinsurgency (CI) Operations</u>

a. <u>Study No. I--Border Patrol Police (BPP) Communications</u>

1) <u>Preliminary Conclusions</u>

The work on this study has been primarily addressed to the accumulation and processing of data. However, one significant conclusion has emerged: The BPP missions in the seven areas vary sufficiently to require the use of different organizations, procedures, and equipment in each area. Therefore, a synthesis of the BPP communications requirements must await the completion of data collection from all area headquarters.

2) <u>Data Collection and Processing</u>

The current level of counterinsurgency activity in Thailand is an example of low-intensity counterinsurgency. The activities at this level are carried on primarily by small units of the BPP. Military participation is limited and highly specialized.

The BPP patrols the Thai borders along a strip some 30 kilometers in depth. This mounting of patrols in remote areas is typical of the kind of activity generated wherever insurgency in its early stages is being countered. Thus, the current activities of the BPP present an excellent opportunity to study the communications problem of low-intensity counterinsurgency. The BPP has platoons deployed along Thailand's more than 2000 miles of common borders with contiguous countries. It is the responsibility of the platoons to inhibit insurgent activity in these areas. They discharge their responsibility by organizing small parties to patrol the area, visiting the populated locations on as frequent a schedule as their resources permit.

The unique and pressing communications problems of low-intensity counterinsurgency operations in Thailand are those encountered by the BPP units and the organization that supports them. The work for Study No. I has therefore been directed toward an understanding of these problems through the development of a detailed body of information on the BPP, their organization, activities, and environment. There are three types of data being compiled:

(1) Description of the BPP organization, communications system, equipment, procedures, personnel, budget, and plans.

(2) Description of the BPP operational environment.

(3) Quantification of current and past BPP operations (patrol activity, communications traffic, incident rates).

The primary sources of useful data so far identified are the BPP Headquarters in Bangkok, the seven area headquarters and their associated platoon bases, USOM, and current studies being conducted by ARPA and associated contractors.

The major effort has been concentrated on data collection from the area headquarters and subordinate platoons. Of the eight headquarters (including Bangkok), five have been visited. Trip reports have been prepared on visits to the headquarters at Chiengmai, Udon, Aranyaprathet, and Kanchanaburi.

The area headquarters have available logs of all messages transmitted and received with date, time, origin, destination, and message content recorded. Arrangements have been made to obtain these records for statistical analysis of the communications traffic.

Each area also maintains a file of reports on patrol activity. A group of these reports, 24 in number, detailing the patrol actions of three platoons over a 3-month period has been obtained and translated, and the information contained has been tabulated. This information includes size of patrol, equipment, duration of patrol, mode of travel, villages visited, distance traveled per day, maximum and daily distance (range) from base, and number and nature of incidents investigated.

Conversations have been held with RAC, RAND, ARPA, and USOM personnel regarding the availability of environmental data. Up-to-date data on population distribution, roads and waterways, and the nature and distribution of vegetation and forest cover have been located.

The Army Concept Team in Vietnam (ACTIV) was visited to determine the extent to which data compiled by that agency would be pertinent to this study. A description of the information available is contained in the trip report prepared for that visit. It was found that the data available at ACTIV are more applicable to Subtasks 2 and 3 than to Subtask 1.

b. Study No. II--Armed Forces Communications Systems

1) Preliminary Conclusions

No conclusions have been derived from this study. However, the data-collection and processing steps have produced a large body of information that would permit definitive conclusions to be developed.

2) Data Collection and Processing

Data on the Thai military forces, including the fixed and semifixed communications systems of each, has been collected in order to evaluate the ability of such systems to support assigned counterinsurgency roles. Data on the Royal Thai Army (RTA) and Royal Thai Marine Corps (RTMC) cover the areas of organization, geographical dispositions, and special counterinsurgency assignments of the forces (e.g., RTA Special Operations Centers and 2nd RTMC Battalion), together with circuit diagrams of some of the fixed systems. Observations made during field exercises and visits to Special Operations Centers produced information on communications equipment, operations, and difficulties encountered.

2. Subtasks 2 and 3--Communications for Medium- and High-Intensity Counterinsurgency (CI) Operations

a. Study No. III--Communications Requirements for Small Units in CI Combat in Tropic Areas

1) Preliminary Conclusions

No conclusions have been derived from this study as yet.

2) Data Collection and Processing

The initial steps in pursuing Study No. III include investigation of the following subjects:

(1) Mid- and long-range threat to the security of Thailand

(2) Contingency policies and plans for the combat employment of Army tactical forces against various postulated threats

(3) The interface of police and military forces and the phasing in of their roles in joint operations

(4) The command-control of joint police and military forces at the medium and high levels of counterinsurgency intensity

(5) Plans for the missions, roles, entry, and deployment of friendly foreign combat forces, and the combined command-control concept for all forces

(6) Existing and planned communications systems and networks to provide for the expected heavy demands for traffic capacity, responsiveness, and reliability at all echelons.

b. <u>Study IV--A Study of the Applicability of Various Communication Transmission Techniques in Support of Small Unit Combat Operations in Tropic Areas</u>

1) <u>Preliminary Conclusions</u>

No conclusions have been derived from this study.

2) <u>Data Collection and Processing</u>

This study is in the preliminary phases of data collection. A major portion of this study will be accomplished in the U.S., including data collection at U.S. Government agencies (Fort Monmouth, Fort Huachuca, U.S. Army Combat Developments Command, Fort Bragg), and U.S. manufacturers of commercial communications equipment (RCA, Philco, ITT, etc.).

3. <u>Subtask 4--Communications Systems Implications of Major Thai Dialects</u>

a. <u>Study No. V--Thai Intelligibility Tests</u>

1) <u>Preliminary Conclusions</u>

It has been found that many of the words contained in lists available in the U.S. are of relatively low frequency of occurrence in spoken Thai or restricted to literary or elegant expressions, and consequently are not suitable for use in an intelligibility test.

It has been concluded that attention should be focused only on Standard Thai (Bangkok Thai). This is the predominant dialect of Thailand, the dialect spoken by the largest segment of the population, and the dialect taught in the schools throughout the Kingdom. There are, however, deviations from Standard Thai dialect and these deviations are large in the outlying areas. In many instances the "dialect" of a particular area might better be considered another language; for example, the "Northeast Dialect" borrows quite heavily from neighboring Laos. In spite of this, it seems clear that the major dialect regions do not introduce any phonological complexities not found in Standard Thai.

2) Data Collection and Processing

Mr. K. D. Dimmick, SRI Menlo Park, visited SRI Bangkok between 13 and 27 August 1964 for the purposes of:

(1) Securing specific information about frequency of occurrence of Thai words

(2) Determining the characteristics of the major Thai dialects

(3) Securing an analysis and recording of segmental and prosodic features of Thai that are not shared by English--e.g., aspiration, tone, and vowel duration

(4) Working out specific plans for the voice communications systems evaluation.

With the assistance of Mr. Lionel G. Thompson, a consultant engaged in Bangkok, additional word lists were obtained from the British Chamber of Commerce, Bangkok. These lists contain a selected vocabulary of approximately 1600 words that occur frequently in

Thai speech. Selected entries will be phonemically analyzed and included in the final vocabulary from which the intelligibility test words will be selected.

Mr. Thompson prepared a series of minimal pairs* for the purposes of demonstrating the phonemic quality of aspiration, tone, and vowel duration for Thai speech. These are phonemic aspects of Thai speech not shared by English.

Three professional radio announcers in Bangkok, each of whom represented an excellent example of Standard Thai were recorded as they recited the minimal pairs illustrating these aspects. The recordings will be used at SRI Menlo Park for determining the signal characteristics necessary for the perception of segmental and prosodic features. Mr. Thompson will prepare additional items of this nature for future experiments, but the most critical recordings have been made.

These stimulus items will be presented to Thai listeners at SRI Menlo Park after they have been subjected to varying degrees of band limiting, reduced signal-to-noise ratio, etc. The data resulting from this set of experiments will be specific to the three attributes under study and will be used to support conclusions drawn from the intelligibility test study and systems evaluations.

b. Study No. VI--Evaluation of Thai Voice Transmission in Tactical Communications Systems

1) Preliminary Conclusions

No conclusions have been derived for this study.

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*The minimal pair is the basic tool of modern descriptive linguistics by which the segmental and supra-segmental features of a language may be identified. In English, for example, lik (leak or leek) and rik (reek) form a minimal pair differentiating between the glides l and r. In Thai, paj (to go) and phaj (danger) form a minimal pair to demonstrate the phonemic nature of aspiration in the language.

2) Data Collection and Processing

The most productive and feasible approach to evaluating the military communication links appears to be to perform the major portion of the effort at SRI Menlo Park using standard military equipment (PRC-10, VHF) and laboratory simulations of system characteristics. However, in order to assure the validity of the findings, additional tests (selected spot-checks) will be executed in Thailand using different listeners.

4. Subtask 5 (Study No. VII)--Survey of Existing Communications Systems

a. Preliminary Conclusions

Based on available information relating particularly to the incompatibilities among the many governmental communications systems, it is tentatively concluded that the existing communications resources probably could not be utilized to their full capability in the event of a national emergency or increased insurgency operations. It is suggested that a single, long-haul communications system and a central communications management authority may be a possible solution to this problem.

It is further tentatively concluded that a modern and efficient radio frequency regulating authority, together with a monitoring system, is a necessity if the predominant radio communications systems are to play an effective role in the national defense of Thailand.

b. Data Collection and Processing

In order to evaluate the capacity and capabilities of Thailand communications systems to support military requirements in an emergency, it is necessary to have an up-to-date catalog of the existing stations and networks. To achieve such a catalog it has been concluded that there is a need to have on record in a central file the essential physical and operating parameters of all radio communications systems in Thailand. This has led to the development of:

[redacted]

(1) Station data forms and associated instructions for completion (to be completed by a cognizant agent of each station)

(2) A central registry form and associated central recording, filing, and cross referencing instructions

(3) A standard operating procedure (SOP) for the "Thai Office of Registration," for maintaining and updating of files and registry

(4) A format for published registry information.

A list of suggested forms and a brief description of each follow:

(1) <u>Radio Station Data Catalog Package</u>

(a) <u>Form No. 1--Thailand: Radio Station Data Catalog</u>

Form No. 1 is the initial form in the station data catalog package. It contains the general information listings--i.e., owner, location, facilities (number of transmitters, type of emission, type of transmitter, etc.), type of radio service, hours of operation, etc.

(b) <u>Form No. 1a--Geographic Map of Thailand</u>

Form No. 1a is a blank map of Thailand and yields a pictorial operational diagram showing details of the radio station and associated system being reported when completed.

(c)* Form No. 1b--Transmitter Engineering Data

Form No. 1b lists the technical parameters necessary to define the transmitting capabilities of the station including antenna and power specifications. It also allows the reporting of either single-channel or multiplex operations. Some additional engineering data is listed that will allow a minimum determination of interfacing capability.

(d)* Form No. 1c--Receiver Engineering Data

Form No. 1c lists the technical parameters necessary to define the receiving capabilities of the station including antenna and power specifications. Additional engineering data is listed that will allow a minimum determination of interfacing capability.

(e) Form No. 1d--Switching Terminal Engineering Data

Form No. 1d lists the pertinent technical parameters necessary to define the terminating capabilities of the station.

(f)* Form No. 1e--Tranceiver Engineering Data

Form No. 1e lists the pertinent technical parameters necessary

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*Items (c) and (d) above pertain to fixed station applications. When portable, mobile, or portable-mobile as well as small capacity fixed stations are reporting, Items (c) and (d) will be omitted and Item (f) data will be collected.

to define the transceiver capabilities of the station including antenna and power specifications.

(2) Central Registry Form

Form No. 2--Radio Station Authorization, Thailand

Form No. 2 is the official registry form. The listings on it are duplications of information listings in the "Radio Station Data Catalog Package." The form consists of an original and four copies. The original will be supplied to the station owner as his official authorization for operation. The four copies will be filed by registry number, call sign, frequency, and radio service. This affords cross referencing capability in these four prime areas. A procedure, "Standard Operating Procedure for Registry Office," to be followed by the Registry Office for the preparation and filing of Radio Station Authorization Form No. 2 was developed. This procedure gives step-by-step instructions for completion and implementation of Form No. 2.

(3) Procedures for the Preparation and Updating of the "Radio Station Registry Frequency List"

The frequency lists are to be published listings of authorized radio stations. They are presented by type of radio service and they include all data necessary for rapid radio station identification. Basis of the lists are registry copy #4 of the Radio Station Authorization--Form No. 2. Each frequency list associated with a particular radio service will consist of Forms No. 3 and No. 4.

(a) <u>Form No. 3--Registry Number and Authorized Owner</u>

Form No. 3 lists in sequential order by register number the authorized owner of the radio stations in each different radio service.

(b) <u>Form No. 4--Operating Frequency and Prime Data</u>

Form No. 4 lists by operating frequency group assigned in each of the types of radio service the prime operating parameters of the authorized stations--i.e., call sign, location, class of service, type of emission, power, etc.

It was found on initial investigation that over 27 separate, independent Government communications systems existed in Thailand, exclusive of privately owned systems. It became apparent also that, in general, access to and gathering of data from the various Thai Ministries and Departments that operate these networks would have to be approved by the Thai Supreme Command. However, those data on Thai communications systems that could be obtained on an informal basis were gathered. These include:

(1) A map and tabulation of the government agencies and population centers having radio stations. This indicated that there were almost 1000 radio stations in Thailand operating under government auspices. Station and network data have yet to be obtained for these stations.

(2) Data indicating the traffic control system, telephone and telegraph (six-level teletype) systems, and station data of the State Railway Systems of Thailand, including the open-wire and radio HF bac' ip circuitry.

(3) Facility layou., traiiic routing, and line route map data on the Toll Telecom System of Thailand (Zones 1, 2, and 3) installed by Collins Radio Co.

(4) The semifixed (AN/TRC-24, AN/MRC-85, AN/TRC-90) radio relay and tropospheric scatter networks operated by the Thai Army and Air Forces.

(5) A tabulation giving locations, frequency, and power of various Thai broadcasting stations.

5. <u>Subtask 6 (Study No. VIII)--Human Engineering and Thai Aptitudes</u>

a. <u>Preliminary Conclusions</u>

No conclusions have been derived from this study.

b. <u>Data Collection and Processing</u>

The program approved by the Thai Supreme Command indicated the need for one Thai officer to assist in gaining access to the identified data sources and to act as interpreter and translator. The latter function is critical, since all records are written in Thai. A Thai officer has not yet been assigned to the subtask. Accordingly, adequate access to essential data has not yet been possible. Some data related to weight-carrying requirements and capabilities of Thai personnel have been obtained from ARPA-RDFU and the Infantry Center at Fort Benning, Georgia. It is intended that information be developed on the following topics, in support of the other elements of Task I:

(1) Thai human resources for implementing communications systems.

(2) Capacity for Thai training facilities to provide necessary trained personnel.

(3) Effect of equipment weight on communications performance, patrolling distances, and patrol vulnerability and fire power.

(4) Catalog of Thai psycho-physical traits that have implications for communications system design and performance.

(5) Language difficulties that affect communications within and among military, police, and other agencies.

E. WORK PLANNED FOR THE NEXT REPORTING PERIOD

1. Subtask 1--Communications for Low-Intensity Counterinsurgency (CI) Operations

a. Study No. I--Border Patrol Police (BPP) Communications

Visits are scheduled to complete the survey of area headquarters and accessible platoon bases. The message logs from the area headquarters will be translated and a statistical picture of the communications flow prepared to show variation in volume of communications by time of day, day of month, geographic area, unit, message content, mode of transmission, frequency, delays, and equipment used.

Additional patrol reports will be obtained and translated and a statistical description of BPP patrol activity will be developed.

The data on environment will be compiled into a comprehensive environmental description pertinent to communications needs and problems.

b. Study No. II--Armed Forces Communications Systems

Visits are being scheduled, with the Supreme Command approval, to (1) the communications installations of the Supreme Command, (2) HQ RTA, (3) the three numbered field armies, (4) the four divisions, (5) several combat teams and separate battalions, (6) the 2nd RTMC Battalion, (7) the RTA Signal Depot and Base Maintenance Company, and (8) the signal and communications schools of all services. Data will be ot .ed on counterinsurgency missions and roles, existing communications networks and systems (procedures, operations, traffic, equipment, maintenance) and personnel training.

2. Subtasks 2 and 3--Communications for Medium- and High-Intensity Counterinsurgency (CI) Operations

a. Study No. III--Communications Requirements for Small Units in CI Combat in Tropic Areas

Data collection will be completed by visits to appropriate offices of JUSMAG-Thailand and MAC-Vietnam, after which a report will be prepared on this study.

b. Study No. IV--A Study of the Applicability of Various Communications Transmission Techniques in Support of Small Unit Combat Operations in Tropic Areas

Data collection will be completed, and the results will be tabulated in a report to show the applicability of communications techniques in terms of the operational parameters of small unit CI operations.

3. Subtask 4--Communications Systems Implications of Major Thai Dialects

a. Study No. V--Thai Intelligibility Tests

This research effort is designed to result in four or five forms of an Intelligibility Test for Standard Thai speech, as well as supporting technical data on the effects of signal degradation on intelligibility of Thai (as compared to similar signal degradation in

English) and specific data on the signal characteristics, if any, that are necessary for the aural perception of features that are phonemic in Thai, but not in English. Types of signal distortions that are of interest in this phase include band limiting, signal-to-noise ratios, signal levels, frequency shifts, etc. It is anticipated that a "first run" intelligibility test will be completed shortly. Concurrent with the development of the test, laboratory experiments with Thai listeners will be conducted on specific minimal pair materials.

The initial draft of a technical report describing the Thai intelligibility test, its rationale, and relevant data regarding the transmission characteristics necessary for intelligible Thai speech is nearing completion. It must be emphasized that there are a number of factors that may delay the completion date. Foremost is the fact that this is a report of basic psychophysical data based on many responses over a substantial number of observations. These data are difficult to acquire and analyze. Second, the observers to be employed (native speakers of Thai) are limited in supply at SRI Menlo Park, and it is possible that difficulty will be encountered in securing adequate numbers of Thai observers at the appropriate times.

b. <u>Study No. VI--Evaluation of Thai Voice Transmission in Tactical Communications Systems</u>

The major portion of the work will be conducted at SRI Menlo Park and will be initiated as soon as an acceptable intelligibility test is available. Following the completion of the system testing at SRI Menlo Park, selected transmission conditions will be evaluated on-site in Bangkok. While it is more difficult to conduct the tests in Thailand for technical reasons, it is deemed necessary to perform some spot-check or support tests there. The most commanding reason is that the Thai listeners available in the United States are university students, and they represent a reasonably small segment of the total population. It therefore becomes quite desirable to perform limited testing in Thailand with military communicators.

Field tests in Thailand are expected to begin early in December and be completed by approximately 15 December 1964. The initial draft of the report covering phase two is anticipated by approximately 15 January 1965.

4. Subtask 5 (Study No. VII)--Survey of Existing Communications Systems

The forms previously described will be translated into Thai. Stations will be visited by SRI members, the forms completed in both English and Thai, the latter retranslated, and both compared for clarity and accuracy. If necessary, the station and catalog entry items will be revised.

The practicability of the proposed procedures and central agency operation will be discussed with representatives of the Supreme Command and Communications Ministry and revised as indicated.

Using the revised forms, a survey of certain government agencies (including military) will be conducted, one by SRI personnel, the others, hopefully, by Thai personnel of the respective ministries or departments, to again judge the practicability of such a survey.

The recommended finalized forms and procedures will be included in the report of the first part of the study. The data obtained from, and conclusions concerning, the conduct and frequency of such surveys will be included in a report on the second part.

5. Subtask 6 (Study No. VIII)--Human Engineering and Thai Aptitudes

If a Thai officer is assigned to the subtask before 1 November 1964, the basic data can be collected in sufficient time to prepare the inputs to a report for the coming period. Without this assistance, any supporting evidence must depend upon subsidiary observations during the course of field trips made for Subtask 1.

Basic data are required on personnel communications skills and abilities, communications performance scores, anthropometric measures, and equipment physical characteristics in order to:

(1) Identify the additional personnel skills needed to support any proposed changes in

the communications systems recommended as a result of work on the other subtasks.

(2) Determine the school and training facilities required to support the communications systems.

(3) Assess the effect equipment weight has on communication performance in terms of patrolling distance and patrol vulnerability and fire power.

(4) Determine the Thai psychophysical traits that have implications for communications system design and performance.

(5) Identify any language difficulties that affect communications within and among military, police, and other agencies and the procedures to eliminate such difficulties.

F. FACILITIES

On 15 August 1964 SRI entered into a lease for two five-room apartments at 4/2 Soi 23, in Bangkok, to accommodate personnel working on the ARPA SEA CORE and SEA SURE operations analysis tasks. The SEA SURE work (on surveillance) has much in common with that of SEA CORE, and contiguous accommodations should benefit both. The facility is a three-story, four-unit apartment building, conveniently located approximately one-half block from Sukhumvith Road (see Fig. 2). Each apartment has an area of 830 square feet of usable space with a total area of 1[illegible] square feet. The 10 rooms have individual 1-ton air conditioners. A telephone is available and there is parking space for six cars. The wide street in front of the apartments provides additional space. The units have a storage room on the second floor and there is room on the first floor of each unit suitable for guards and drivers.

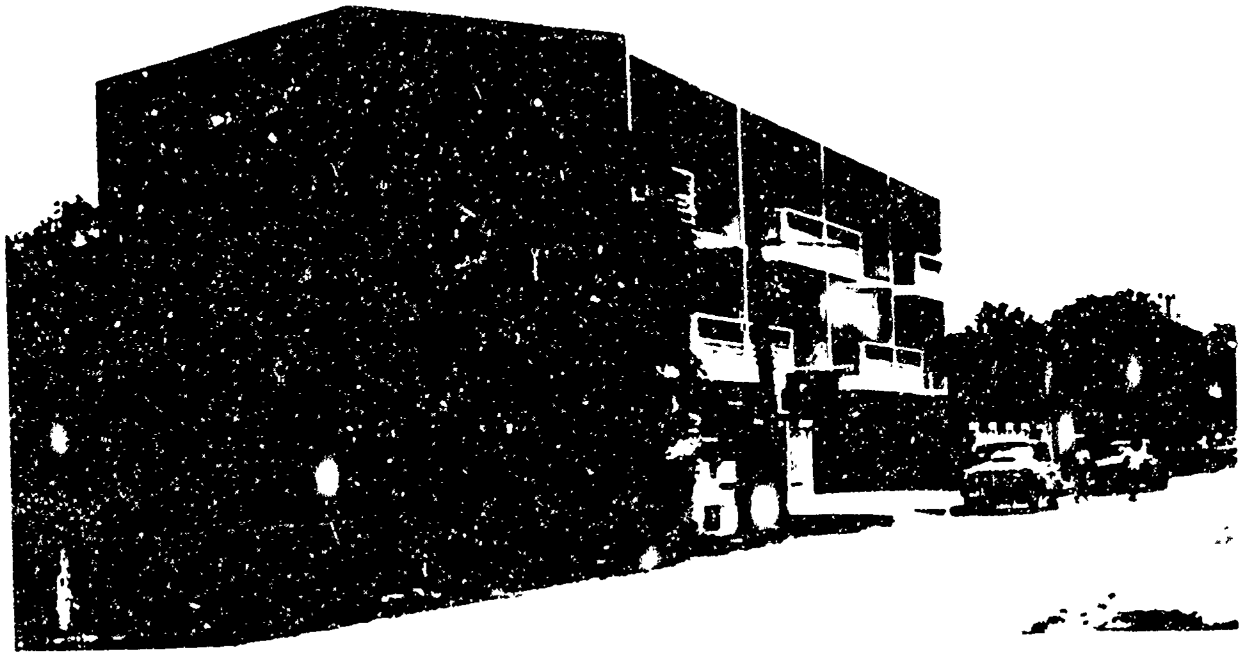

FIG. 2 APARTMENT BUILDING AT 4/2 SOI 23, BANGKOK

[redacted]

The term of the lease is for 6 months, commencing 15 August 1964 and en[illegible] 15 February 1965. [illegible] has the option to renew on the same terms and conditions up through 30 June 1966.

III TASK II--SCIENTIFIC AND TECHNICAL INVESTIGATIONS

A. PROGRAM OBJECTIVES

During the reporting period, a series of conferences was held between ARPA, USAEL, Thailand, and SRI representatives to review the specific subtask assignments. As a result of these conferences, it was agreed that all major work efforts should be restricted to the following revised set of subtasks:

Subtask 1--Test and Evaluate Tactical Communication Techniques and Devices

Subtask 2--Conduct RF Noise Measurements

Subtask 3--Conduct Antenna Orientation Investigation

Subtask 4--Conduct Measurement of Ground Constants

Subtask 5--Conduct Special Magnetic and Ionospheric Investigations

Subtask 6--Investigate Ionospheric Factors Related to Local Frequency Prediction

Subtask 7--Investigate Effects of Tropical Environment on Antenna Performance

Subtask 8--Analyze Vertical-Incidence Ionospheric Measurements.

B. WORK ACCOMPLISHED DURING REPORTING PERIOD

During the reporting period, work was accomplished on all the above subtasks. A summary of the work accomplished on each subtask follows.

1. Subtask 1--Test and Evaluate Tactical Communication and Devices

Field tests on selected VHF man-pack radio sets over the flat delta region near Bangkok have been completed. The principal objective of the tests was to determine the maximum effective operating distance of the various sets using their standard whip antennas and under controlled conditions simulating potential operational situations. Secondary objectives were to compare variations in performance between day and night, to examine the effect of varying the frequency channel used, and to obtain some rough idea of performance variations with changes in antenna position and height.

The tests were made in a region free of villages and man-made construction. The region is used for rice growing and contains the usual low dikes and waterways found in such areas; no significant changes in elevation exist. During the test period, no rain fell and the water table was low.

The following radio sets were employed:

AN/PRC-25

AN/PRC-25 with 15-watt amplifier

AN/PRC-25 with 35-watt amplifier

AN/PRC-35 (XC-3)

Motorola Handi-Talkie.

Table I summarizes the results obtained. A report describing these results in more detail is being prepared.

A general evaluation of an HF radio set designated the RTA-318 was completed. This set is manufactured by the G. Simon Company in Bangkok, Thailand. The tests were conducted to evaluate its suitability as a light-weight man-portable set for use by the Special Operations Center of the Royal Thai Army.

The RTA-318 is a fully transistorized, single-channel, crystal-controlled radio t operating only in a CW mode and powered from C-size dry cells. It is small and highly portable, with a total weight including power source of 12 pounds.

A draft of the test report, entitled "Engineering Evaluation of the RTA-318 Radio Set," has been written.

Table I

EFFECTIVE RANGES FOR RADIO SETS TESTED

Set	Frequency (Mc)	Power (watts)*	Effective Range (miles)
AN/PRC-25	35	2.0	4.2
	51	1.9	5.4
	65	1.7	3.4
AN/PRC-25 With power amplifier, 15w	35	15.0	8.0
	51	15.0	12.0
AN/PRC-25 With power amplifier, 35w	35	35.0	9.0
	51	35.0	13.2
AN/PRC-35 (XC-3)	35	0.8	2.0
	51	0.7	1.0
	65	0.7	1.4
Motorola Handie-Talkie	50.7	1.5	1.2

Height of sets: Base 2.5 ft above ground for both transmitter and receiver.

Antenna lengths: AN/PRC-25 10 ft
AN/PRC-35 (XC-3) 3 ft
Motorola 1.5 ft

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*Transmitter power output into a matched load.

2. Subtask 2--Conduct RF Noise Measurements

Initial measurements of the radio noise environment are under way, using loaned equipment and v ous field expedients. These measurements include continuous recording of RF noise frequencies of 1.5, 6.0, 27, 51, 120, and 200 kc. Since May 1964, a lightning-flash counter similar to one located in Singapore has been operating, so that the occurrence of strong lightning flashes can be monitored. A direction finder consisting of a pair of crossed loop , two amplifiers, a cathode-ray-tube display, and a recording camera has been constructed and is in operation. Special noise measurements have been conducted in a survey of possible low-noise sites.

The design of RF noise-measuring equipment for the HF band has been completed. Equipment similar to and compatible with the National Bureau of Standard's newly designed ARN-3 noise-measuring equipment has been selected.

Records from the six-channel VLF/LF noise recorder have shown the expected diurnal variation in noise level; however, local storms frequently cause large increases over the normal noise background. High-frequency and VHF noise records obtained as by-products from other experiments indicate that man-made noise levels are high near Bangkok. For example, overmodulation and harmonic components from broadcast transmitters have been found on the C-2 sounder data, and automobile ignition noise is prevalent.

The lightning-flash counter responds to only very strong electrical impulses and generally to only local lightning flashes. It was constructed by graduate students of Chulalongkorn University, and initial tests were carried out in the University's high-tension laboratory. It has been operational at the MRDC Electronics Laboratory since May 1964. Figure 3 illustrates the wide variation in local lightning activity.

The data shown are taken with an arbitrary fixed threshold level held constant during the over-all period. Further effort is under way to calibrate the triggering level of the counter in terms of an incident electric field strength, to calculate the approximate range of the counter, and to correlate data obtained with local storm activity.

3. <u>Subtask 3--Conduct Antenna Orientation Investigations</u>

Early in the program it was recognized that the reflection of radio waves from the ionosphere near the magnetic equator would be affected by polarization of the radiated signals.[1*] During this report

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*References are given at the end of the report.

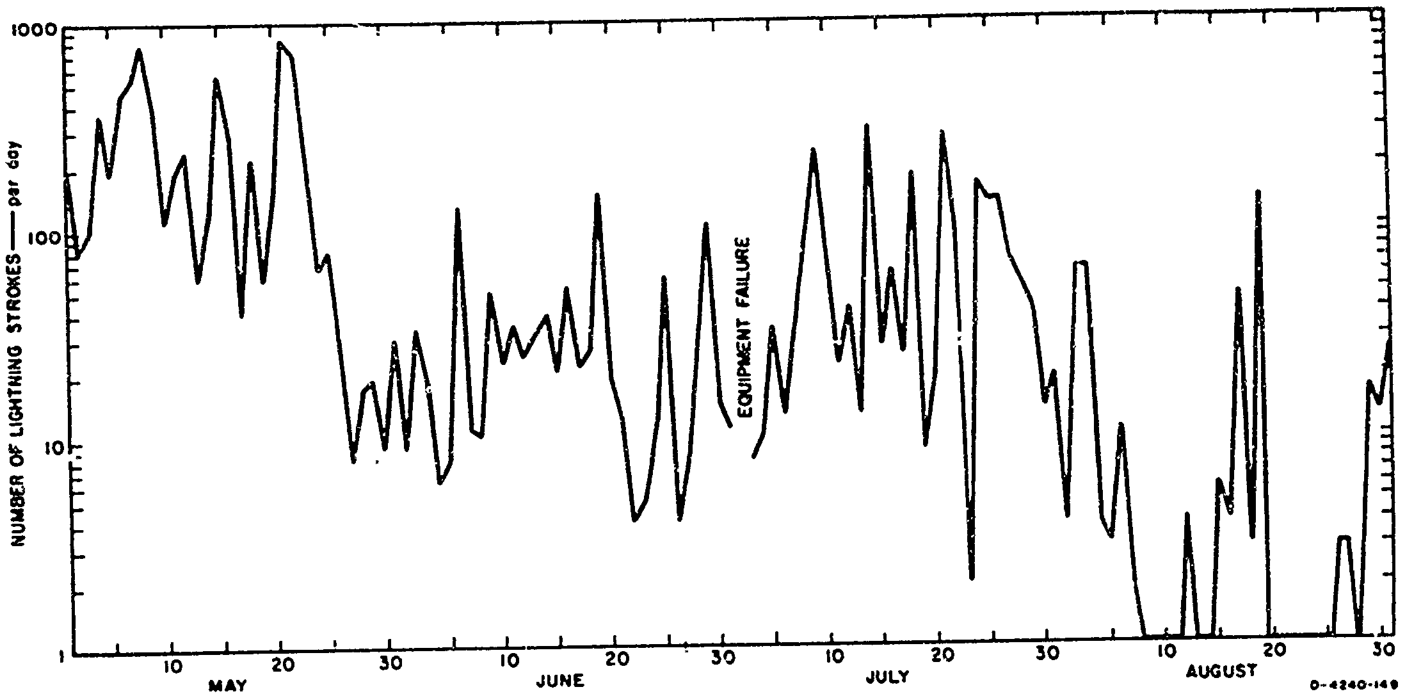

FIG. 3 LOCAL LIGHTNING ACTIVITY IN THE VICINITY OF BANGKOK, THAILAND

period, field tests were continued to measure the magnitude of signal levels by using various antenna polarizations. Sites at Ayutthaya and Nakhon Pathom, which are approximately 60 km due north and due west of Bangkok, respectively, have been used as remote receiver sites, and a transmitter has been operated at the MRDC Electronics Laboratory near Bangkok. Transmissions have been made at 1.7, 3, 5, and 10 Mc, using both north-south and east-west half-wave dipole antennas.

Initial results of CW measurements are shown in Figs. 4 through 10. Each curve represents the average of five days of data. The effect of the orientation of antennas on received signal strengths is pronounced in the lower frequencies. In the higher frequencies it becomes insignificant, as shown in the 10-Mc data. Some caution must be used in the interpretation of the 10-Mc data because the signals from the near-vertical-incidence path are believed to have been contaminated by signals received over long-distance backscatter modes of propagation (see p. 46).

Tests using pulse transmissions to identify the existence of unusual propagation modes have been started. Preliminary results confirm the general findings of the CW tests.

4. Subtask 4--Conduct Measurements of Ground Constants

The electrical properties of the earth determine the effective groundwave coverage for transmitters operating in the lower part of the HF spectrum and determine the efficiency of antennas that depend upon ground conductivity in their vicinity.

Over an imperfectly conducting ground, the electric field of the radio wave transmitted from a vertical antenna tilts forward slightly from the vertical axis. The tilt angle, θ, at which the electric field tilts, depends on the frequency, conductivity, and dielectric constant of the ground in the path of propagation. At a sufficiently high frequency, the tilt angle depends largely on the dielectric constant of the ground, and these are related by the equation

$$\tan \theta \cong \frac{1}{\sqrt{\epsilon}}$$

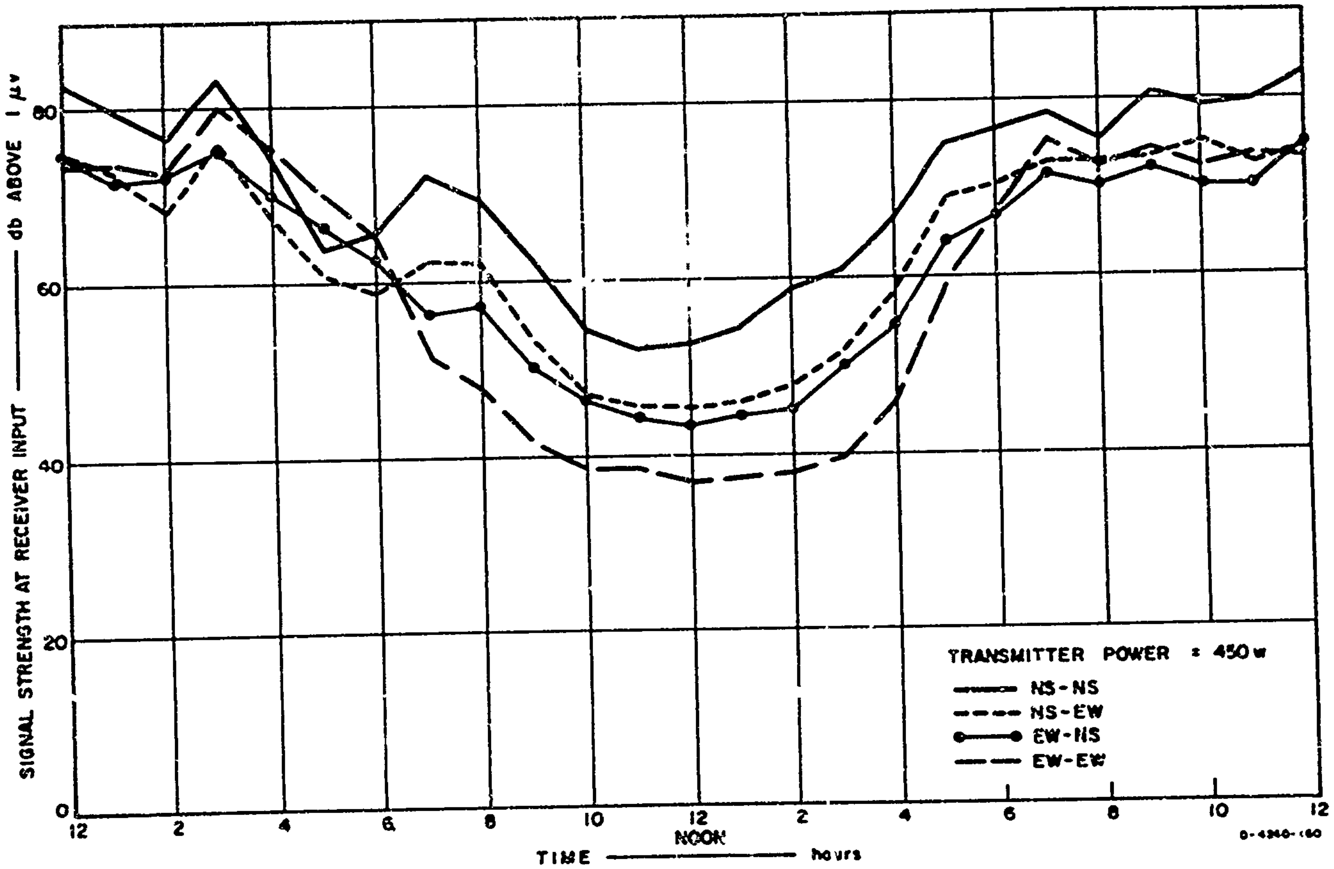

FIG. 4 RESULTS OF CW MEASUREMENTS — AYUTTHAYA, 1.7 Mc

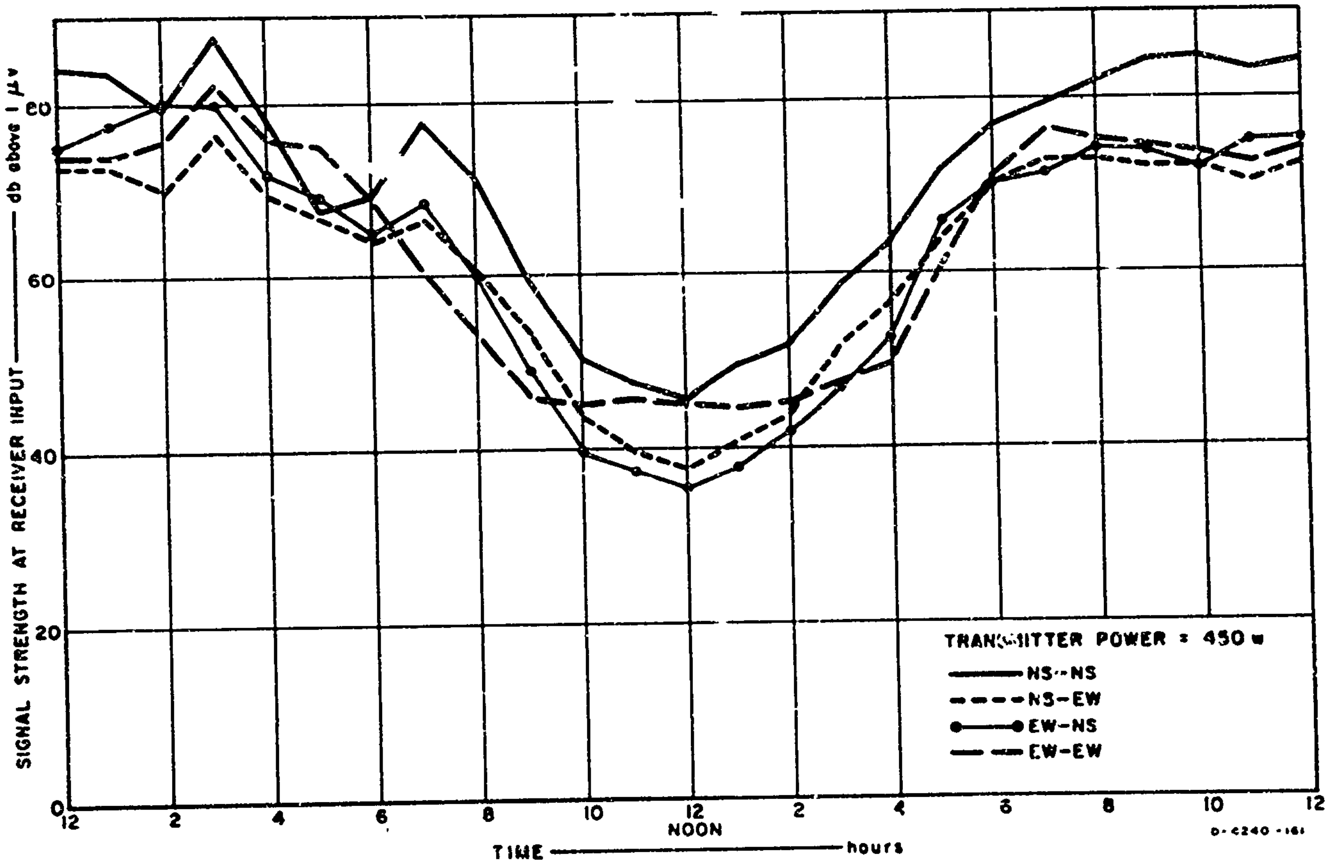

FIG. 5 RESULTS OF CW MEASUREMENTS — NAKHON PATHOM, 1.7 Mc

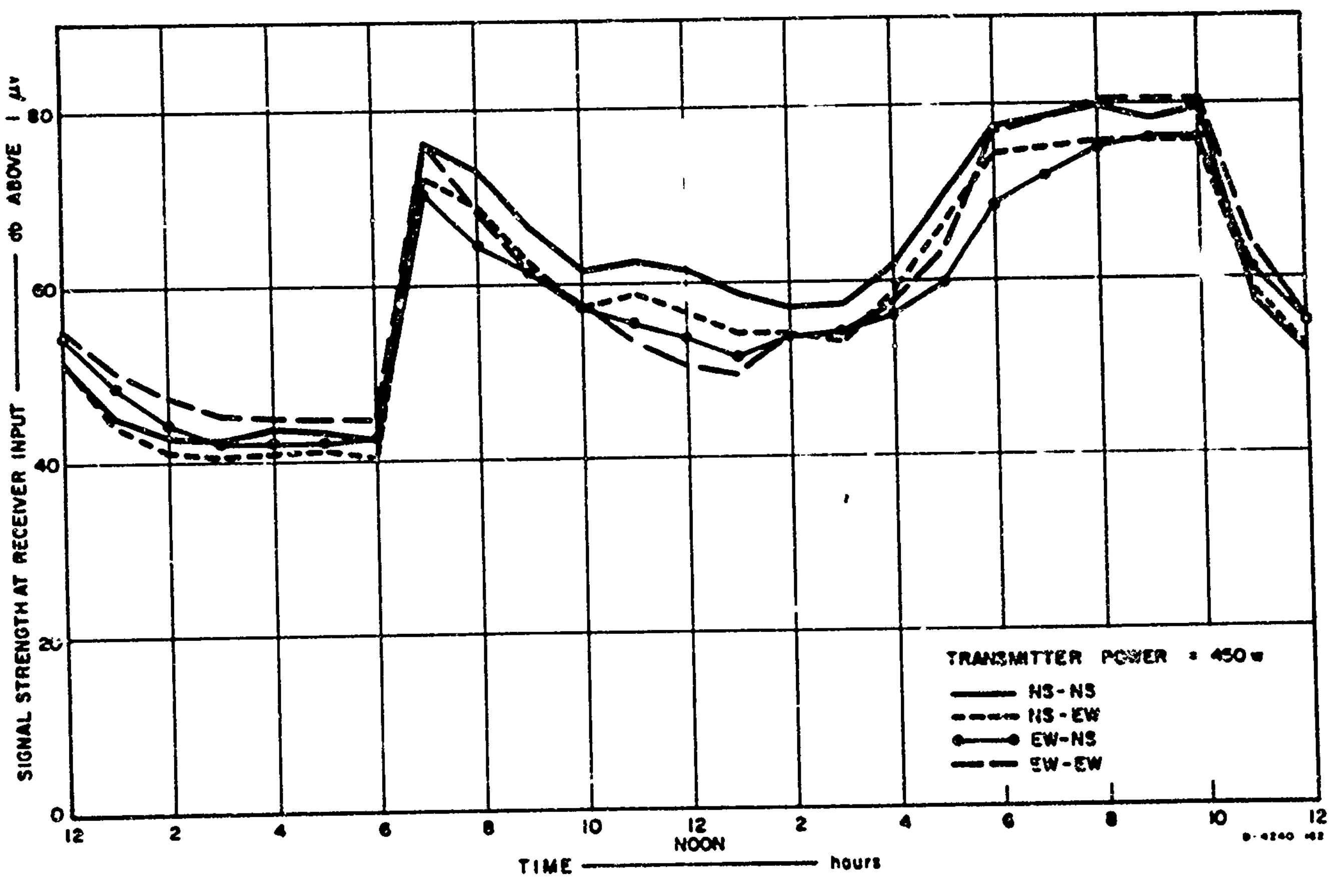

FIG. 6 RESULTS OF CW MEASUREMENTS — AYUTTHAYA, 3 Mc

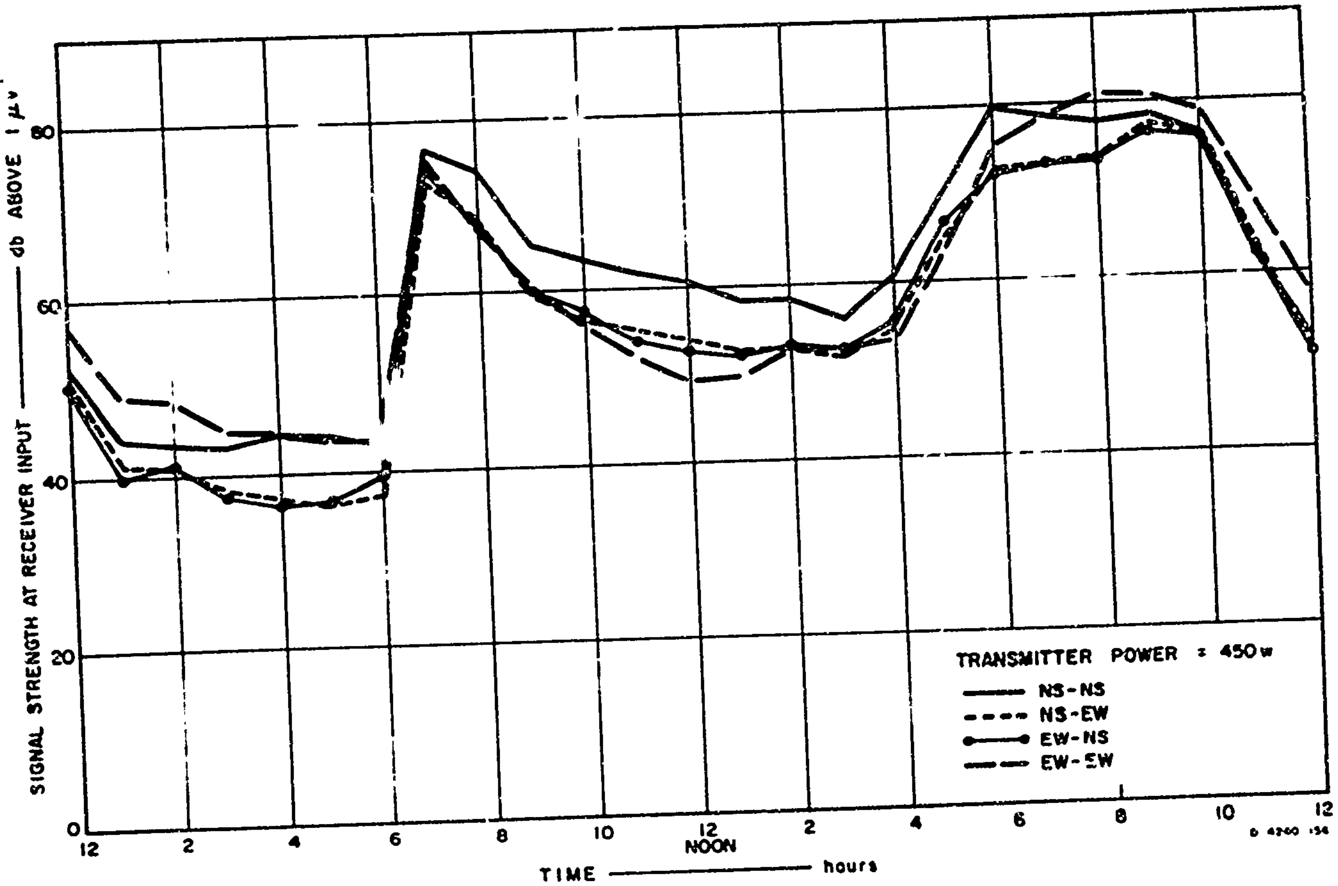

FIG. 7 RESULTS OF CW MEASUREMENTS — NAKHON PATHOM, 3 Mc

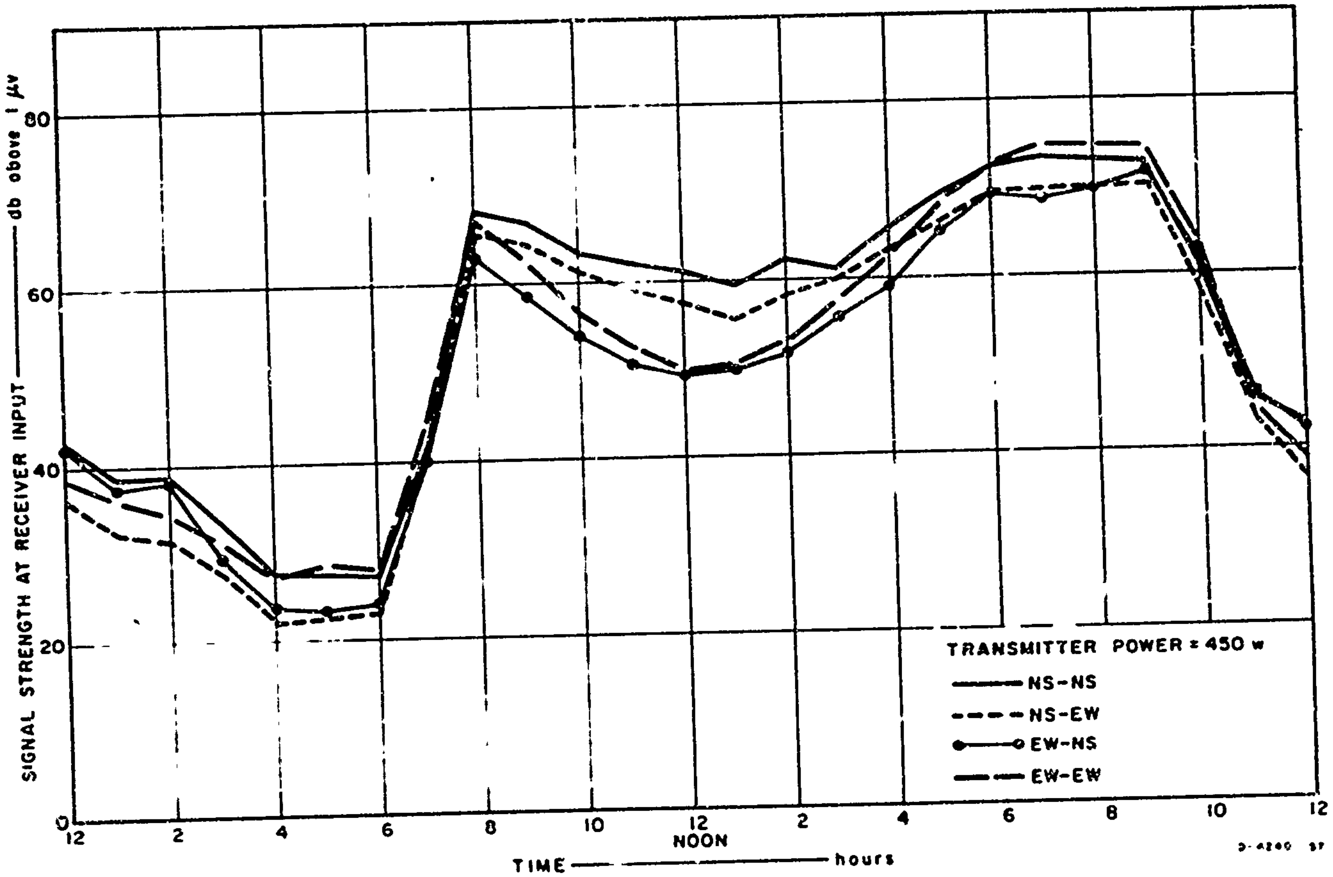

FIG. 8 RESULTS OF CW MEASUREMENTS — AYUTTHAYA, 5 Mc

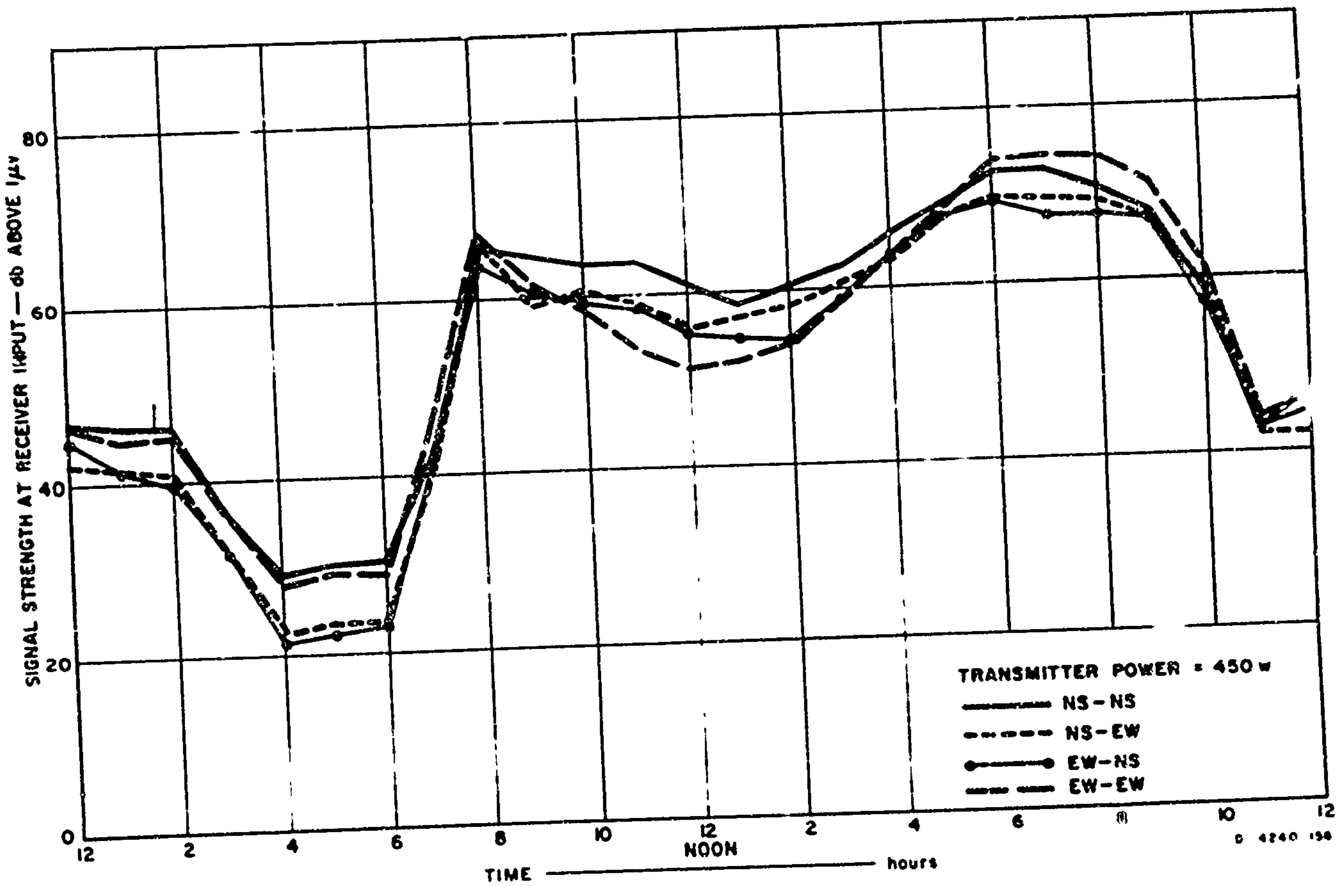

FIG. 9 RESULTS OF CW MEASUREMENTS — NAKHON PATHOM, 5 Mc

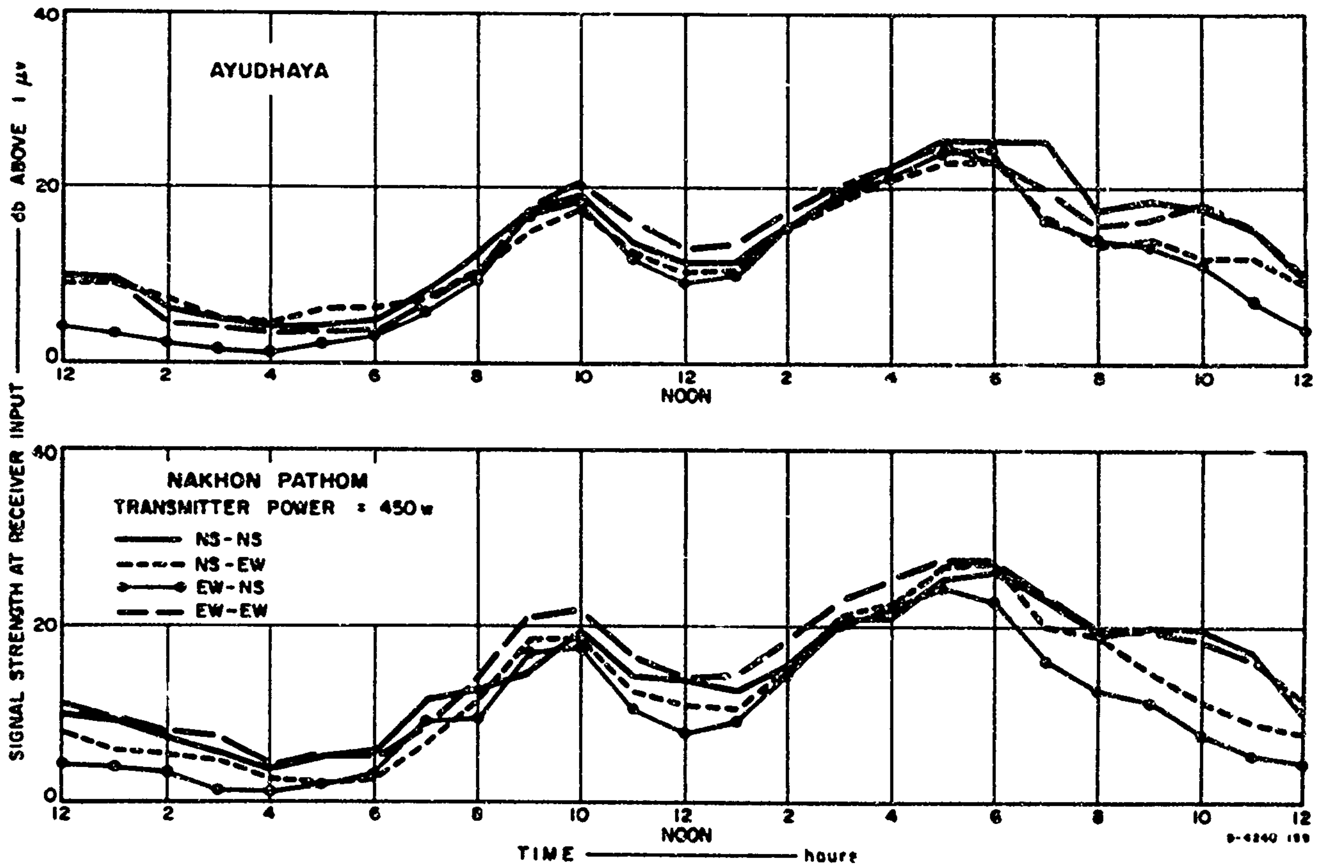

FIG. 10 RESULTS OF CW MEASUREMENTS — AYUTTHAYA AND NAKHON PATHOM, 10 Mc

where ϵ is the dielectric constant, thus giving the value of ϵ when the tilt angle is known.

To measure the tilt angle, a dipole is placed in the electric field and oriented until it receives minimum signal--i.e., when it is parallel to the electric field. The angle of the dipole can then be measured.

Equipment for measuring the tilt angle of vertically polarized transmitting radio waves was built and tested. It consists of a remote-control rotating dipole antenna with built-in transistorized preamplifier and signal-strength indicator. The dipole antenna is balanced. A remote control is necessary because of the capacitance effect between the experimenter and the dipole antenna. Vertically polarized radio waves are launched by a battery-operated 27-Mc transmitter and portable vertical antenna.

Measurements were made at 42 sites covering the central and northeastern part of Thailand. Measured values of the dielectric constant range between 7 and 20 and are indicated by the numbers on Fig. 11, for the northeastern area.

Ground conductivity has been determined by the following method: Field intensity curves as a function of distance from a transmitter were computed for different values of ground constants. These curves were then compared with measured field-intensity data taken at various distances from the transmitter. Correlation of normalized measured data with computed data then resulted in values for ground constants. Norton curves[2] have been computed by IBM 1620 computer and plotted. This involved programming the computer for computing a Norton curve at frequencies of 820 and 1455 kc. At each frequency, the dielectric constant varied from 10 to 60 in steps of 10; the conductivity varied from 0.5 mmho/m to 40 mmho/m in steps of 1 mmho/m at the lower value and 10 mmho/m at higher values. This involved 3000 calculations and resulted in 20 pages of curves containing 200 graphs.

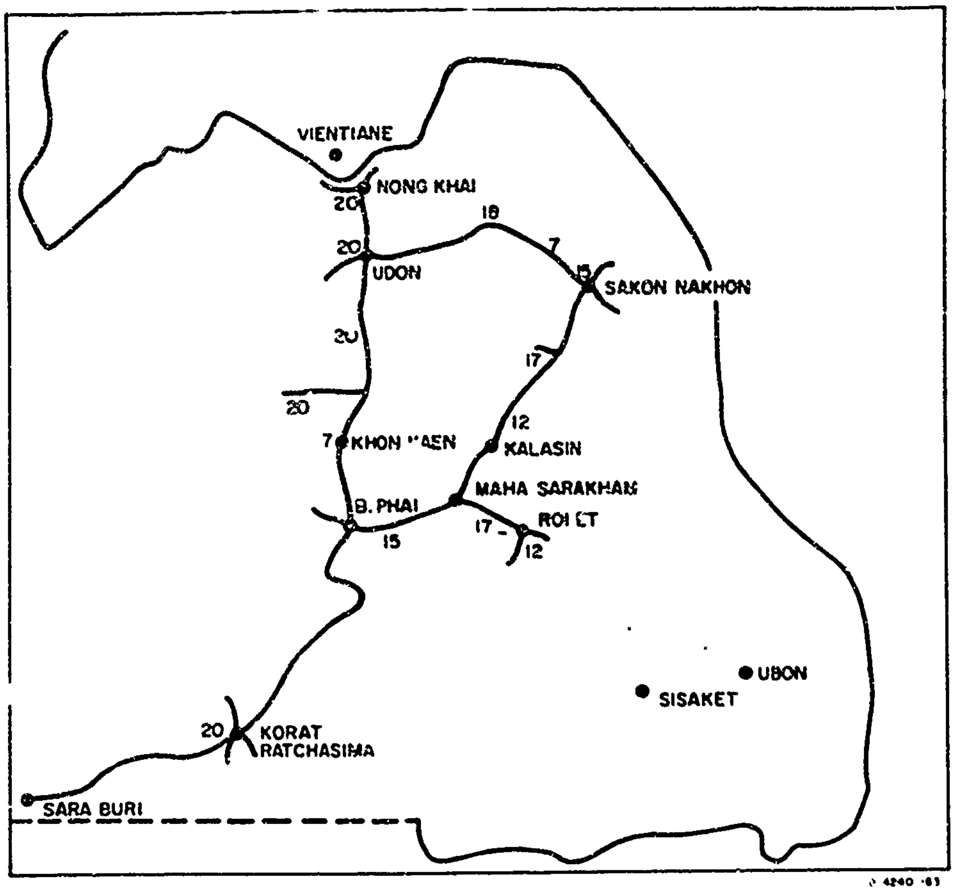

FIG. 11 MAP OF NORTHEASTERN THAILAND SHOWING MEASURED VALUES OF DIELECTRIC CONSTANT

Transmitters on frequencies of 820 and 1455 kc and various types of vertical antennas and matching networks have been built and tested. To assist in evaluating the free-space field, E_o, at a unit distance, a loop antenna was constructed.

Field intensity was measured in the vicinity of Bangkok, Ban Pong, and Bang Pra In in central Thailand and in the vicinity of Korat, Udon, and Sakon Nakhon in the northeast. Measurements were taken from three directions at each of these six sites, at distances from 1 to 50 miles--at 1-mile intervals up to 10 miles and then at 10-mile intervals up to 50 miles.

The evaluation of ground conductivity during the wet season has been almost completed, and the measurements for central and part of northeast Thailand were finished at the end of August. The analysis of initial results has been started. Ground conductivity in central Thailand was found to be 40 mmho/m in the wet season, when that area is covered with water.

5. <u>Subtask 5--Conduct Special Magnetic and Ionospheric Investigations</u>

The earth's magnetic field and the ionosphere exert great influence on tropical communications at HF. The effect of the magnetic field is especially important near the magnetic equator, and it has been observed that the earth's static equatorial magnetic field is greater near Thailand than it is elsewhere in the world. The earth's magnetic field affects the refractive index of the ionosphere and causes magneto-ionic splitting of radio waves, which can make some antenna orientations more effective than others. Important characteristics of the ionosphere that affect radio communications include its relative absorption, electron density, and equivalent layer thickness.

Meanwhile, the recording of 54-Mc signals from the Transit 4A satellite has been continued. Faraday rotation is measured, and results are translated into accumulated electron content values.

A device for automatically turning the system on and off has been constructed, along with automatic time markers to insure satisfactory records around the clock.

A typical data sheet is shown in Table II. Figure 12 shows how the accumulated electron content varies with time of day over Bangkok and also illustrates the day-to-day variations. Insufficient data have been accumulated to allow estimating accumulated electron content during the period 2400 to 0400 hrs, a period of very low ionospheric ionization levels.

Table II

TYPICAL DATA SHEET SHOWING FARADAY FADING RECORDS FOR TRANSIT IV-A AT BANGKOK, AND ELECTRON CONTENT OF UNIT COLUMN EVALUATED THEREFROM

Date (1964)	Revolution No.	Time (UT) Initial	Terminal	To	Faraday Rotations	foF2 (Mc)	Ndh $10^{8}e/m^2$	Remarks
2 June	14825-A	0324	0330	0327.46	2.6	2.7	18.01	
2 June	14831-D	1430	1436	1433.95	0.35	2.5	2.27	
3 June	14838-A	0155	0201	0157	2.4	6.8	15.37	
3 June	14844-D	1259	1305	1302.76	1.0	4.6	6.48	
4 June	14852-A	0207	0214	0210.91	2.7	6.4	18.74	
4 June	14858-D	1313	1319	1316.40	0.85	5.8	5.50	
5 June	14866-A	0220	0227.5	0224.55	2.6	6.4	18.04	
10 June	14940-D	1107	1115	1110.57	2.5	7.0	16.11	
11 June	14948-A	0016	0022	0018.21	1.4	6.4	9.72	
11 June	14954-D	1121	1128	1124.21	2.6	9.0	16.75	
12 June	14962-A	0027	0035	0031.21	2.0	5.2	13.96	
12 June	14968-D	1135	1141	1137.85	2.6	8.5	16.76	
13 June	14976-A	0041	0049	0046.19	1.6	5.6	11.15	
13 June	14982-D	1148	1156	1151.49	2.4	7.0	15.52	
14 June	14989-A	2313	2318	2316.00	0.8	3.9	5.19	
14 June	14996-D	1202	1209	1205.13	2.9	8.5	20.34	
15 June	15009-D	1031	1039	1034.94	3.0	7.8	19.38	
16 June	15017-A	2338	2346	2343.28	0.75	5.0	5.24	
16 June	15023-D	1045.5	1252.5	1248.58	2.4	7.1	15.52	
17 June	15031-A	2353	2359	2336.92	1.0	5.5	6.97	
17 June	15036-D	0916	0922	0918.17	2.3	7.7	15.50	
17 June	15037-D	1101.5	1108	1102.22	2.4	7.5	14.86	
18 June	15044-A	2221	2229	2226.73	0.26	1.6	1.83	
18 June	15050-D	0926	0937	0931.82	3.2	7.5	20.68	
19 June	15064-D	0942	0948	0945	2.5	7.6	16.15	
20 June	15078-D	0958	1004	0959.02	2.5	8.2	16.11	
21 June	15092-D	1012	1017	1012.72	2.6	7.7	16.79	
22 June	15099-A	2133	2140	2137.08	0.1	2.3	0.70	
27 June	15168-A	2058	2104	2101.42	0.6	2.2	44.23	
27 June	15174-D	0804	0812	0806.87	2.8	7.2	8.10	
28 June	15182-A	2111	2119	2115.05	0.3	2.2	2.14	
28 June	15188-D	0819.5	0825	0820.30	3.1	8.0	20.08	
29 June	15201-D	0548	0556	0550.30	2.9	6.5	18.77	

6. <u>Subtask 6--Investigate Ionospheric Factors Related to Local Frequency Prediction</u>

High-frequency radio circuits depend upon lc -term propagation predictions to give average indicators of performance and assist in the selection of proper frequencies. Field communication equipments

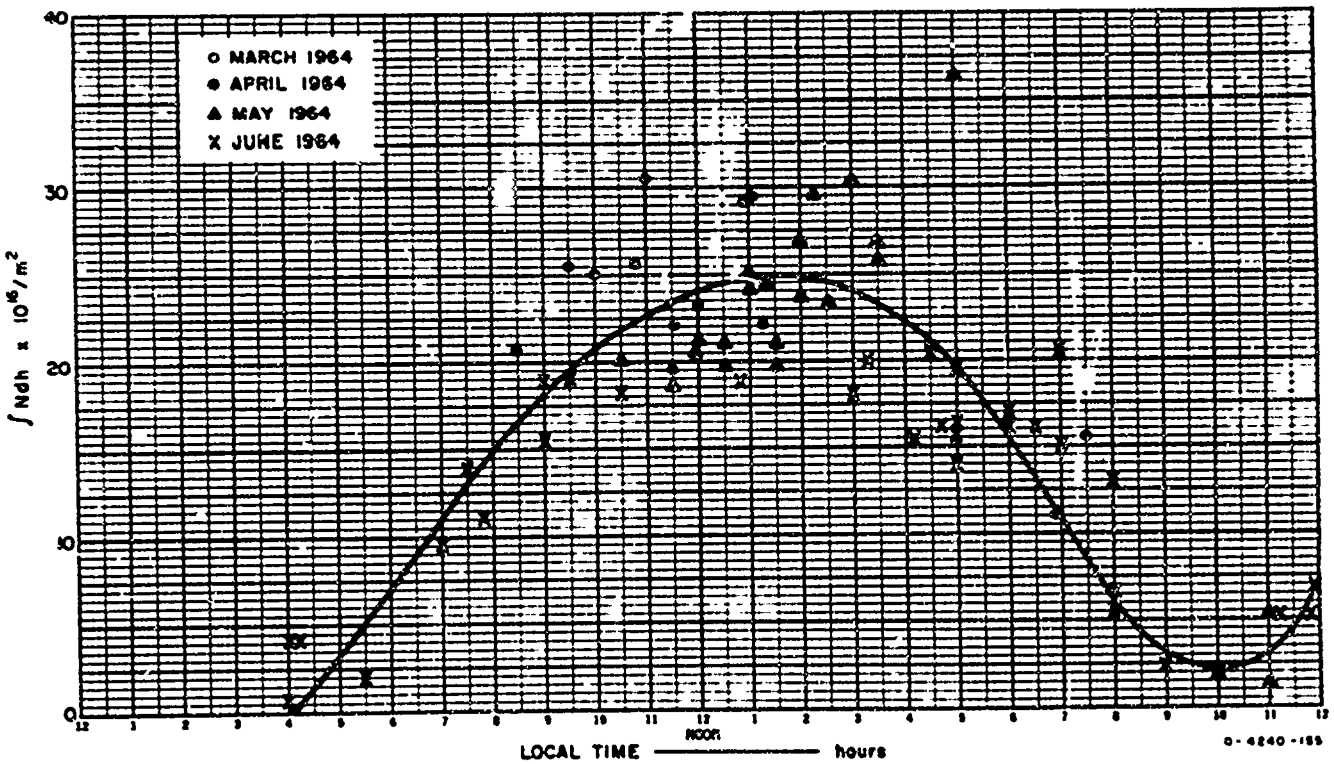

FIG. 12 DIURNAL VARIATION OF TOTAL ELECTRON CONTENT OVER BANGKOK

use very-low-powered sets, frequently in non-optimum system configurations. The application of short-term prediction techniques should result in a significant improvement in their communication capability.

Predictions of the maximum usable frequency (MUF) and the lowest usable frequency (LUF) have been supplied for special tests and for special operations. (See comments on Exercise Kitti 07 in Final Report covering period 1 September 1962 to 29 February 1964 for this contract.[3]) During several field tests in Thailand, weak signals have been observed well above the MUF. Equipment for precise mode identification is not yet available in Thailand. It is believed the weak signals are similar to those seen on short paths in the United States, where, with positive mode identification provided by oblique-incidence sounders, most such instances of propagation at unusually high frequencies have been related to E-region reflection or to long-range backscatter modes.

To further investigate short-path communications, special oblique-incidence sounder transmissions have been conducted over paths in California from a transmitter located at Mountain View to receivers located at the following sites:

Receiver Site	Path Length (km)
Milpitas, California	18
Tracy, California	66
Sonora, California	153
Sonoma, California	97
Bridgeport, California	259
Middletown, California	157
Coyote Hills, California	13
Saratoga, California	21
Knights Ferry, California	132
Hawthorne, Nevada	327

The above short path tests were made possible by the convenient physical arrangement and location of sounders required to accomplish work under Contract DA-28-043-AMC-00082(E) where distance dependence variations in long-range propagation were ·der inves· ation. Since the field tests are still under way, only a few data have been examined. Ground-wave signals are clearly separable from sky-wave signals. The ionograms resemble those from vertical-incidence sounders. Long-distance ground backscatter is frequently seen on records examined.

Further examination of ionograms is expected to show the usefulness of the oblique sounder to positively identify the modes of propagation existing over a short path. Thus the relative importance of ground wave vs. sky wave over the terrain examined in this test can be established. The presence of long distance backscatter modes of propagation has already been demonstrated and it must now be considered when examining HF field communications. Further data on the backscatter mode are expected from the test.

7. Subtask 7--Investigate Effects of Tropical Environment on Antenna Performance

The very high values of attenuation observed on past measurements have suggested a careful examination of the effective radiation pattern of tactical antennas in tropical forest areas.[4] Dense vegetation appears to result in high attenuation to radiation at low angles from an antenna immersed in foliage. Initial computations of radiation-pattern distortion at low angles because of attenuation from foliage have been started.

It is believed that no significant progress can be made on this subtask until full scale measurements of antenna patterns can be made over open flat terrain, slopes of bare hills, and in heavy forests. The Xeledop pattern-measuring technique seems well suited for such a task.[5,6,7]

8. Subtask 8--Analyze Vertical-Incidence Ionospheric Measurements

The Model C-2 vertical-incidence sounder supplied by the USARPA has been operating continuously since September 1963. The sounder is operated and data are scaled by USARPA technicians. The first of a series of monthly data reports--that for May 1964--was published during this reporting period.[8]

C. WORK PLANNED FOR THE NEXT REPORTING PERIOD

1. Subtask 1--Test and Evaluate Tactical Communication and Devices

   (1) Test VHF man-pack sets in tropical forest regions and compare results with tests completed over open flat delta regions.

   (2) Examine RCA narrow-band equipment and conduct special tests as appropriate.

2.* Subtask 2--Conduct RF Noise Measurements

   (1) Continue operation of the six-frequency noise recorder.

   (2) Continue operation of the lightning-flash counter.

   (3) Construct HF noise-measuring equipment similar to the NBS ARN-3 system.

   (4) Select a new quiet-region site for noise measurements.

3. Subtask 3--Conduct Antenna Orientation Investigation

   (1) Complete analysis of CW and pulse data.

   (2) Prepare reports describing results of field tests.

   (3) Investigate theoretical aspects of antenna orientation and its relationships to diversity-receiving systems for short-range tropical communications.

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*Total plan contingent upon acceptance of supplementary proposal.

4. <u>Subtask 4--Conduct Measurements of Ground Constants</u>

(1) Complete field measurements now in progress.

(2) Prepare a report describing results of field measurements and study efforts.

5.* <u>Subtask 5--Conduct Special Magnetic and Ionospheric Investigations</u>

(1) Continue routine reception of satellite signals and production of monthly data summaries of electron content of the ionosphere by Faraday rotation measurements.

(2) Analyze and correlate data with such factors as magnetic activity, fmin, foF, and other ionospheric parameters available.

(3) Procure and install a magnetometer and riometers at the MRDC Electronics Laboratory.

(4) Procure and install a Dopplometer at the MRDC Electronics Laboratory.

6.* <u>Subtask 6--Investigate Ionospheric Factors Related to Local Frequency Prediction</u>

(1) Provide special predictions as required for communication problems in Southeast Asia.

(2) Outfit and ship to Thailand two oblique-incidence sounders being purchased by the USARPA.

(3) Start field tests using the oblique-incidence sounders, in accordance with the implementation test plan.

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*Total plan contingent upon acceptance of supplementary proposal.

7.* Subtask 7--Investigate Effects of Tropical Environment on Antenna Performance

(1) Measure patterns of selected tactical antennas over flat land near Lodi, California. Continue measurements with antennas installed on hillsides and in the forest area of the Northwestern United States.

(2) Prepare for antenna pattern measurements in forest areas of Thailand.

8. Subtask 8--Analyze Vertical-Incidence Ionospheric Measurements

(1) Continue support of the C-2 sounder operated by the USARPA.

(2) Continue the publication of C-2 ionosonde data in monthly reports.

(3) Interpret C-2 data in terms of parameters useful to field communication, such as MUFs, LUFs, and daily and seasonal variations in these parameters.

D. FACILITIES

The MRDC laboratory van structure, the headquarters building, and field facilities have been described in the earlier semi-annual reports and the final report covering the first 18 months of operation.[3,9,10] While small improvements have been made, the facilities described in earlier reports have not been significantly changed. All equipment, buildings, and grounds have been maintained in good condition.

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*Total plan contingent upon acceptance of supplementary proposal.

The three 60-kw General Motors diesel generators supplying power to the laboratory and the C-2 sounder have accumulated sufficient operating time that overhaul is required. Parts and experienced mechanics are available from the General Motors distributor in Bangkok.

Six ONAN 10-kw generators used for field work have accumulated sufficient operating time to receive their second overhaul. Although the field generators are still in excellent condition, it will be necessary to start planning their replacement.

IV PUBLICATIONS AND CONFERENCES

A. PUBLICATIONS

Verbal approval was obtained for the publication on Task II of the revised Research Memorandum 5, entitled "Orientation of Linearly Polarized HF Antennas for Short-Path Communication via the Ionosphere near the Geomagnetic Equator."

Approval for the publication, on Task II, of Monthly Ionospheric Data Reports was received. Draft bulletins have been completed for the months of March, April, and June 1964; the report for May has been published.

B. VISITS AND CONFERENCES

Numerous conferences were held during the reporting period. These are summarized and listed below.

1. In March, Lt. Col. Ranvier visited the MRDC Electronics Laboratory to make measurements on a "squashed rhombic" antenna.

2. During 1-16 March, Capt. Prapat Chandaket, MRDC Electronics Laboratory Coordinator, and Lt. Col. J. F. Scoggin, ARPA RDFU-T Communications Program Manager, met with the Operations Analysis staff regarding proposed revision of the Operations Analysis program.

3. On 6 March, Mr. A. J. Mandelbaum and Mr. R. E. Morse visited Hq. Planning Group for Exercise AIR BOONCHOO, Air Academy, Don Muang for orientation and determination of extent of SRI participation.

4. During 9-12 March, Mr. R. E. Leo and Capt. K. M. Irish visited Saigon, Vietnam to discuss communication problems with Lt. Col. Ranvier. Problems of the DECCA low frequency navigation system were discussed with several officers and DECCA representatives, at the request of Mr. Brundage.

5. On 13 March, Lt. Col. James Jones of ARPA, Washington, D.C. and Dr. G. J. Zissis of IDA, Washington, D.C. visited the MRDC Electronics Laboratory. They were briefed on technical program efforts and escorted through the T-van complex by Lt. Col. Scoggin.

6. During 15-19 March, Mr. R. E. Morse visited Vietnam for an exploration of data sources and investigation of data exchange possibilities between MRDC Electronics Laboratory and test units in Vietnam.

7. On 20 April, Mr. F. T. Mitchell and Mr. L. Sturgill, Jansky & Bailey, met with Mr. A. J. Mandelbaum, Mr. R. E. Leo, and other Operations Analysis and Technical Program staff members regarding objectives and scope of Jansky & Bailey program.

8. On 22 April, Mr. A. J. Mandelbaum and Mr. R. E. Morse visited Ubon and Korat Airbases for observation of communications aspects of Exercise AIR BOONCHOO.

9. On 24 April, Mr. A. J. Mandelbaum and Mr. R. E. Morse visited Pitsanuloke, Tahkli and Don Muang Airbase for observation of communications aspects of Exercise AIR BOONCHOO.

10. On 29 April, Mr. R. E. Leo and Mr. N. K. Shrauger visited Don Muang Airbase for observation of communications aspects of Exercise AIR BOONCHOO.

11. On 7 May, Mr. R. E. Leo and Captain Udom Suwanpramott visited the Thai Army Signal Corps Headquarters, Bangkok to inspect its facilities and discuss its participation in the frequency-prediction verification experiment.

12. On 11 May, Lt. Col. V. Bloecher, U.S. Army Signal Corps, briefed SRI staff members on the results of Exercise AIR BOONCHOO applying to communications.

13. On 12 May, Mr. A. J. Mandelbaum, Mr. R. E. Morse, and Lt. Col. J. F. Scoggin, ARPA RDFU-T visited the Thai RCT, Udorn, for acquisition of data on Thai BPP and Army unit communications and related factors.

14. During 12-23 May, Mr. R. E. Leo visited research centers in Hong Kong, Macao, and Japan to exchange information on ionosondes, lightning-flash counters, noise measurements, satellite Faraday rotation experiments, and satellite communications.

15. On 13 May, Mr. A. J. Mandelbaum, Mr. R. E. Morse, and Lt. Col. J. F. Scoggin, ARPA RDFU-T, visited the Thai RCT, Chiengmai, for acquisition of data on Thai BPP and Army unit communications and related factors.

16. From 17 May through 26 June, Mr. H. P. Blanchard visited Bangkok to coordinate project activities.

17. On 1 June, Capt. Prapat Chandaket, Electronics Laboratory Coordinator, Mr. H. P. Blanchard, Project Supervisor, Maj. J. A. Kranz, COR/COTR, USAEL Thailand, Capt. K. M. Irish, Assistant COR/COTR, USAEL Thailand, and Mr. R. E. Leo met to review and consider proposals for Technical Program.

18. During 8-9 June, Mr. R. E. Leo visited Sattahip to observe dipole orientation tests.

19. On 11 June, Mr. R. E. Leo, Lt. Jamnong Sowanna, Mr. Dan Pierce, and Mr. Rangsit Chindhaporn visited the Meteorological Department, Royal Thai Navy and met with Captain Prasert Soontarotok, Forecasting, Captain Dr. Kajit Buajitti, Climatology, and Mr. Smith, Communications, to discuss meteorological activities, thunderstorm activity, noise DF equipment, and meteorological publications in Thailand.

20. On 12 June, Mr. R. E. Leo and Lt. Jamnong Sowanna visited Mr. Suwan, Chief Engineer, Ministry of Telephone and Telegraph, Bangkok, to discuss satellite communications and frequency control.

21. On 22 June, Major General Wienecke, Director for Remote Area Conflict, ARPA Washington, visited the SRI operation for a tour of the MRDC Electronics Laboratory and a briefing on current projects.

22. From 22 June through 3 July, Mr. W. R. Vincent visited Bangkok to coordinate Task II activities.

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23. From 28 June through 2 July, Mr. A. J. Mandelbaum, Mr. R. E. Morse and Lt. Col. J. F. Scoggin, ARPA RDFU-T, visited Vietnam to investigate the availability and value of counterinsurgency communications data.

24. On 29-30 June, Mr. George Watts, U.S. Army Electronics Laboratories, Fort Monmouth, New Jersey, visited SRI, Menlo Park.

25. From 30 June through 2 July, Dr. John Taylor visited the U.S. Army Electronics Laboratories, Fort Monmouth, New Jersey.

26. On 8 July, Mr. H. P. Blanchard visited ARPA, Washington. On 10 July, Mr. W. R. Vincent visited ARPA, Washington.

27. During 13-16 July, Dr. T. Meeland and Mr. J. A. MacLeod visited Vietnam to exchange information with Army concept Team in Vietnam and coordination with SRI representative.

28. During 22-24 July, Major General Singchai Menasuta, RTA, Lt. Col. Chaiyo Krasin, RTA: Col. Bui Quang Trach, ARVN; 1st Lt. Huynh Thuan, ARVN; and Lt. Col. J. L. Jones, USA, visited SRI, Menlo Park.

29. On 23 July, Mr. R. E. Leo visited Subtask 4 work under way near Korat, Thailand.

30. During 27-29 July, Mr. David Paul and Mr. T. E. Simonton of Atlantic Research Corporation, Alexandria, Virginia, visited SRI, Menlo Park, to film project activities.

31. During 28-29 July, Mr. R. A. Kulinyi and Mr. H. L. Kitts, U.S. Army Electronics Laboratory, Fort Monmouth, New Jersey, visited SRI Menlo Park.

32. On 30-31 July, Mr. W. R. Vincent visited ARPA, Washington, to review project activities.

33. During 4-7 August, Mr. J. A. MacLeod and Mr. R. E. Morse visited the BPP Regional Installation, Udorn, and platoon outposts, for acquisition of data on BPP internal and interface communications.

34. On 13 August, Mr. H. P. Blanchard visited ARPA, Washington.

35. On 13 August, Mr. P. Dubois, International Telecommunications Union Technical Assistance Board, and Mr. Watana Sumawong, Chief Training Officer, ITU, visited Mr. A. J. Mandelbaum and Mr. R. E. Leo to discuss areas of common interest in communications research.

36. On 13-14 August, Mr. E. Rivera and Mr. G. Urgan of the U.S. Army Electronic Proving Ground, Fort Huachuca, visited SRI Menlo Park, to discuss the field testing of radio sets.

37. During 13-27 August, Mr. K. D. Dimmick, audiologist, Operations Analysis Department, SRI Menlo Park, and Mr. L. Thompson, Lecturer, Chulalongkorn University, met with Operations Analysis staff members to discuss communications systems implications of major Thai dialects (Task I, Subtask 4).

38. On 17-18 August, Mr. R. L. Brown and Mr. G. H. Hagn visited Mr. J. Crichlow, National Bureau of Standards Laboratory, Boulder, Colorado, to discuss noise measurements.

39. On 20-21 August, Mr. W. R. Vincent visited the Defense Research Corporation of Santa Barbara, California, to discuss long-term plans for AGILE.

40. On 28 August, Mr. J. A. MacLeod, Mr. R. E. Morse and Police Lt. Col. Thinakorn Orntuam visited the 7th BPP Area, Kanchanaburi to acquire data pertaining to low-level counter-insurgency communications (Task I, Subtask 1).

41. On 31 August, Mr. R. L. Brown and Mr. W. R. Vincent visited ARPA, Washington, to discuss Task II work.

V KEY PERSONNEL

(1) <u>Communication Laboratory</u>

W. R. Vincent, Manager, Communication Laboratory, Menlo Park

R. E. Leo, Technical Director, Bangkok

G. D. [illegible]sen, Project Administrator, Bangkok

R. D. Daniel, Field Engineering Representative, Bangkok

W. N. Ward, Field Engineering Representative, Bangkok

G. H. Hagn, Research Engineer, Menlo Park

T. S. Cory, Research Engineer, Menlo Park

W. A. Ray, Research Engineer, Menlo Park

J. Taylor, Staff Scientist, Menlo Park

R. L. Brown, Research Engineer, Menlo Park

(2) <u>Subcontract Technical Personnel</u>

C. L. Rufenach, Research Engineer (Montana State College), Bangkok

N. K. Shrauger, Research Engineer (Montana State College), Bangkok

F. Phillips, Field Engineer (Vitro), Bangkok

D. Lyons, Junior Field Engineer (Vitro), Bangkok

K. Taylor, Junior Field Engineer (Vitro), Bangkok

J. Chapman, Junior Field Engineer (Vitro), Bangkok

(3) <u>Operations Analysis Department</u>

A. J. Mandelbaum, Operations Analyst and Senior SRI Representative, Bangkok

H. F. Erickson, Technical Writer, Bangkok

J. A. MacLeod, Operations Analyst, Bangkok

R. R. Mann, Operations Analyst, Bangkok

Tor Meeland, Research Psychologist, Bangkok

R. E. Morse, Operations Analyst, Bangkok

K. D. Dimmick, Research Audiologist, Menlo Park

T. W. Cook, Research Engineer, Menlo Park

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